PATENT COOPERATION TREATY

From the INTERNATIONAL BUREAU

PCT

NOTIFICATION OF ELECTION

(PCT Rule 61.2)

To:

Assistant Commissioner for Patents
United States Patent and Trademark Office
Box PCT
Washington, D.C.20231
ÉTATS-UNIS D'AMÉRIQUE

in its capacity as elected Office

Date of mailing (day/month/year) 04 February 2000 (04.02.00)	
International application No. PCT/GB99/01574	**Applicant's or agent's file reference** PDG/20637
International filing date (day/month/year) 17 May 1999 (17.05.99)	**Priority date** (day/month/year) 15 May 1998 (15.05.98)
Applicant WESTON, Martin et al	

1. The designated Office is hereby notified of its election made:

[X] in the demand filed with the International Preliminary Examining Authority on:

10 December 1999 (10.12.99)

[ ] in a notice effecting later election filed with the International Bureau on:

2. The election [X] was

[ ] was not

made before the expiration of 19 months from the priority date or, where Rule 32 applies, within the time limit under Rule 32.2(b).

The International Bureau of WIPO
34, chemin des Colombettes
1211 Geneva 20, Switzerland

Facsimile No.: (41-22) 740.14.35

Authorized officer

Olivia RANAIVOJAONA

Telephone No.: (41-22) 338.83.38

G/C

PCT WORLD INTELLECTUAL PROPERTY ORGANIZATION
International Bureau

INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(51) International Patent Classification 6 : H04N 5/44 — A1

(11) International Publication Number: **WO 99/60780**

(43) International Publication Date: 25 November 1999 (25.11.99)

(21) International Application Number: PCT/GB99/01574

(22) International Filing Date: 17 May 1999 (17.05.99)

(30) Priority Data:
9810555.4 15 May 1998 (15.05.98) GB

(71) Applicant *(for all designated States except US)*: SNELL & WILCOX LIMITED [GB/GB]; 6 Old Lodge Place, St. Margaret's, Twickenham TW1 1RQ (GB).

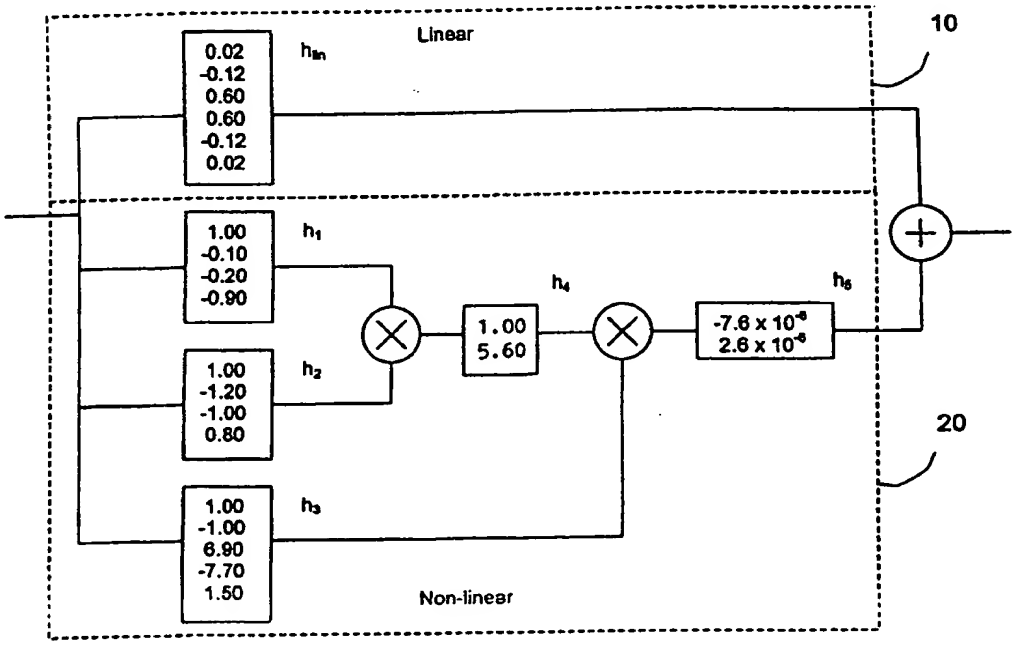
(72) Inventors; and
(75) Inventors/Applicants *(for US only)*: WESTON, Martin [GB/GB]; 7B Weston Road, Petersfield, Hampshire GU31 4JF (GB). COLLIS, William, Beninfield [GB/GB]; Lee's Cottage, 19 Jones Lane, Hyvhe, Southampton, Hampshire SO45 6AW (GB).

(74) Agents: GARRATT, Peter, Douglas et al.; Mathys & Squire, 100 Gray's Inn Road, London WC1X 8AL (GB).

(81) Designated States: AU, CA, JP, US, European patent (AT, BE, CH, CY, DE, DK, ES, FI, FR, GB, GR, IE, IT, LU, MC, NL, PT, SE).

Published
With international search report.

(54) Title: VIDEO SIGNAL PROCESSING



(57) Abstract

A method of de-interlacing a video signal by conducting three linear filtering operations on the input to produce three filtered signals, each linear filtering operation comprising the taking of a weighted sum of pixels; and multiplying together the three filtered signals to produce an output video signal.

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Codes used to identify States party to the PCT on the front pages of pamphlets publishing international applications under the PCT.

AL	Albania	ES	Spain	LS	Lesotho	SI	Slovenia
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DE	Germany	LI	Liechtenstein	SD	Sudan		
DK	Denmark	LK	Sri Lanka	SE	Sweden		
EE	Estonia	LR	Liberia	SG	Singapore		

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first and second filters; and a second multiplier for multiplying together the respective outputs of the first multiplier and the third filter to produce an output video signal.

Advantageously, a filter is interposed between the output of the first multiplier and the second multiplier.

Preferably, the apparatus further comprises a linear filter path connected with the input terminal, and a combiner for combining the outputs of the linear filter path with the output of said second multiplier.

Suitably, a filter is interposed between the output of the second multiplier and said combiner.

The invention will now be described by way of example with reference to the accompanying drawings in which:

Figure 1 is a block diagram of video signal processing apparatus according to the invention, in the form of a vertical de-interlacing filter; and

Figure 2 is a diagram similar to Figure 1, illustrating a modification.

The example will be taken of a de-interlacer and, for reasons of clarity, a de-interlacer will be described that utilises only vertical information. It will be understood that horizontal and temporal information could be included in ways which will be immediately evident to the skilled reader.

In Figure 1, the new architecture can be seen to consist of two signal paths. A linear signal path 10 contains a traditional, vertical, six tap, linear filter (h_{lin}) which has a typical sin(x)/x structure. If this were to be used without the non-linear signal path it would produce reasonable pictures, but they would contain some artefacts due to the interpolation process, notably jagging on diagonal and curved edges.

In the non-linear signal path 20, the output of two four point linear filters (h_1 and h_2) are multiplied together and passed through a two point linear filter (h_4). The output of this is then multiplied with the output of a five point linear filter (h_5). The resulting signal is filtered through another two point linear filter (h_6) before being added on to the linear path. Although in this case the

In summary, the new architecture is able to reduce many of the artefacts associated with traditional linear interpolation whilst being relatively simple to implement.

Figure 2 illustrates a modification in which the architecture is simplified through omission of the filters h_4 and h_6. In other words, the direct product is formed of the outputs of filters h_1, h_2 and h_3 without intervening filtering of the product of the outputs of filters h_1 and h_2. This may under some circumstances produce less ideal filter behaviour, but the reduction in hardware complexity will often more than compensate. A particular advantage is that the three remaining filters can all make use of the same memory architecture.

It should be understood that this invention has been described by way of example only and that a wide variety of modifications are possible without departing from the scope of the invention. Thus, whilst the separation into linear and non-linear paths offers important advantages, such as the option to preserve higher bit accuracy in the linear path, it will not always appropriate. Similarly, the described use of vertical filters is - as has been explained - merely an example. Horizontal, vertical and temporal filters can be employed and filters can have one, two or three of these dimensions. Whilst Finite Impulse Response (FIR) filters will be important, the invention also encompasses other forms of linear filter such as recursive filters which include the output pixel in the weighted sum. The filters which are to be multiplied together need not be of the same category. However, providing three FIR or transversal filters with the same filter aperture ensures that in the multiplication of the three filtered signals, all possible cross products of input pixels are made available.

It will be recognised that although de-interlacing has been chosen as an example, filters according to the present invention can be applied to other problems in video processing, including composite to component decoding, enhancement, noise reduction, up and down conversion and standards conversion -.

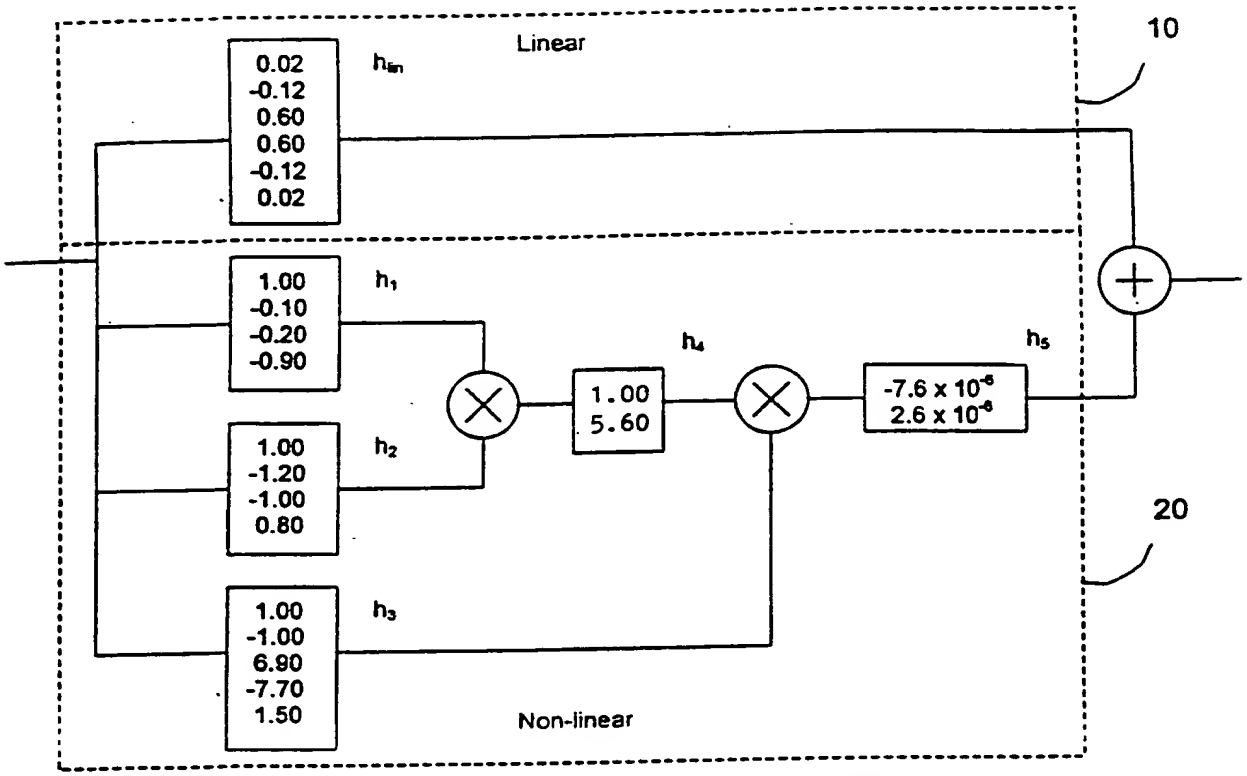

Figure 1

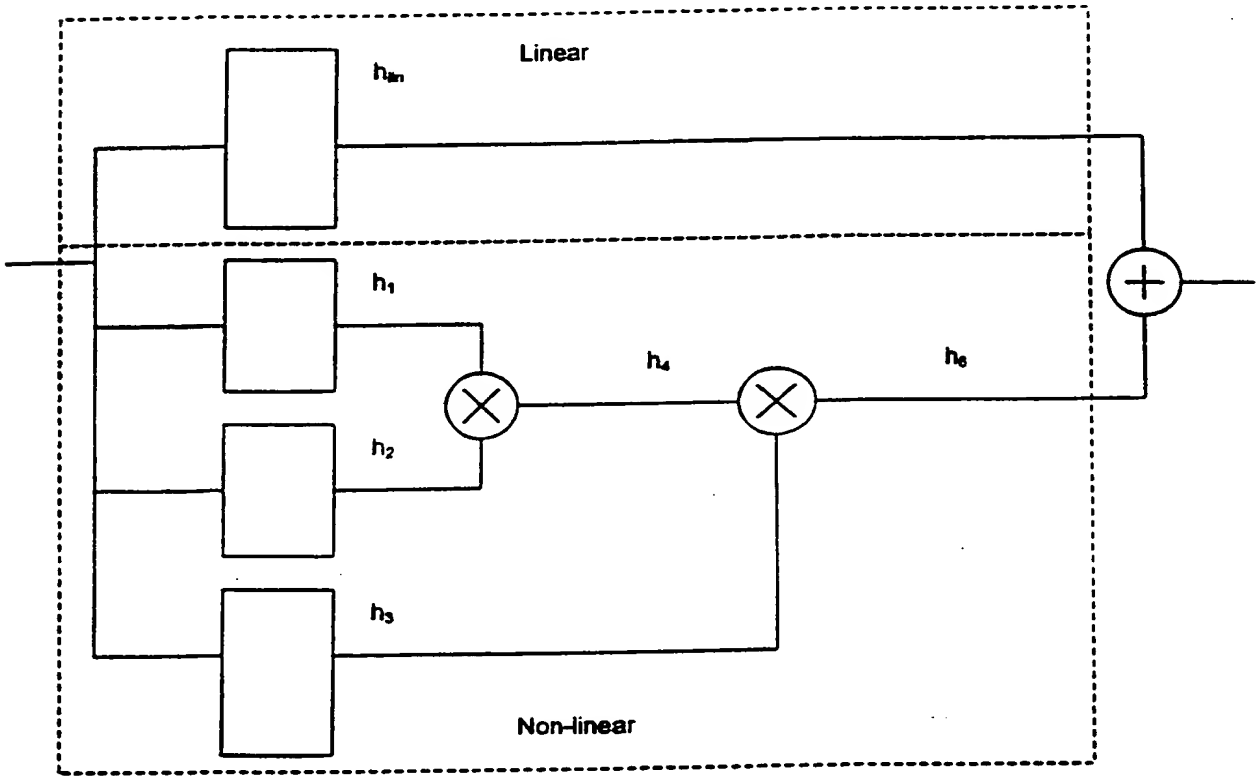

Figure 2

INTERNATIONAL SEARCH REPORT

Inter. ..nal Application No
PCT/GB 99/01574

A. CLASSIFICATION OF SUBJECT MATTER
IPC 6 H04N5/44

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
IPC 6 H04N

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category °	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 5 652 620 A (ASAKAWA KATSUMI ET AL) 29 July 1997 (1997-07-29) column 12, line 35 - line 63; figures 26,33,35,36 column 17, line 52 - column 18, line 32 column 19, line 22 - column 20, line 11	1,6,8,13

☐ Further documents are listed in the continuation of box C.

☒ Patent family members are listed in annex.

° Special categories of cited documents :

"A" document defining the general state of the art which is not considered to be of particular relevance

"E" earlier document but published on or after the international filing date

"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art.

"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
12 August 1999	20/08/1999

Name and mailing address of the ISA	Authorized officer
European Patent Office, P.B. 5818 Patentlaan 2 NL - 2280 HV Rijswijk Tel. (+31-70) 340-2040, Tx. 31 651 epo nl, Fax: (+31-70) 340-3016	Yvonnet, J

Form PCT/ISA/210 (second sheet) (July 1992)

INTERNATIONAL SEARCH REPORT

Information on patent family members

Intern al Application No
PCT/GB 99/01574

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
US 5652620 A	29-07-1997	EP 0554035 A	04-08-1993
		JP 2821072 B	05-11-1998
		JP 6086302 A	25-03-1994
		US 5450124 A	12-09-1995

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PATENT COOPERATION TREATY

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INTERNATIONAL PRELIMINARY EXAMINATION REPORT

(PCT Article 36 and Rule 70)

Applicant's or agent's file reference	FOR FURTHER ACTION	See Notification of Transmittal of International Preliminary Examination Report (Form PCT/IPEA/416)
PDG/20637		
International application No.	International filing date *(day/month/year)*	Priority date *(day/month/year)*
PCT/GB99/01574	17/05/1999	15/05/1998
International Patent Classification (IPC) or national classification and IPC H04N5/44		
Applicant SNELL & WILCOX LIMITED et al.		

1. This international preliminary examination report has been prepared by this International Preliminary Examining Authority and is transmitted to the applicant according to Article 36.

2. This REPORT consists of a total of 4 sheets, including this cover sheet.

   ☒ This report is also accompanied by ANNEXES, i.e. sheets of the description, claims and/or drawings which have been amended and are the basis for this report and/or sheets containing rectifications made before this Authority (see Rule 70.16 and Section 607 of the Administrative Instructions under the PCT).

   These annexes consist of a total of three sheets.

3. This report contains indications relating to the following items:

   - I ☒ Basis of the report
   - II ☐ Priority
   - III ☐ Non-establishment of opinion with regard to novelty, inventive step and industrial applicability
   - IV ☐ Lack of unity of invention
   - V ☒ Reasoned statement under Article 35(2) with regard to novelty, inventive step or industrial applicability; citations and explanations suporting such statement
   - VI ☐ Certain documents cited
   - VII ☒ Certain defects in the international application
   - VIII ☒ Certain observations on the international application

Date of submission of the demand	Date of completion of this report
10/12/1999	21.07.2000
Name and mailing address of the international preliminary examining authority: European Patent Office D-80298 Munich Tel. +49 89 2399 - 0 Tx: 523656 epmu d Fax: +49 89 2399 - 4465	Authorized officer Weber-Kluz, F Telephone No. +49 89 2399 8630

Form PCT/IPEA/409 (cover sheet) (January 1994)

INTERNATIONAL PRELIMINARY EXAMINATION REPORT

International application No. PCT/GB99/01574

I. Basis of the report

1. This report has been drawn on the basis of (*substitute sheets which have been furnished to the receiving Office in response to an invitation under Article 14 are referred to in this report as "originally filed" and are not annexed to the report since they do not contain amendments.*):

Description, pages:

1,3	as originally filed			
2,4	as received on	05/06/2000	with letter of	02/06/2000

Claims, No.:

1-15	as originally filed

Drawings, sheets:

1/1	as received on	05/06/2000	with letter of	02/06/2000

2. The amendments have resulted in the cancellation of:

☐ the description, pages:
☐ the claims, Nos.:
☐ the drawings, sheets:

3. ☐ This report has been established as if (some of) the amendments had not been made, since they have been considered to go beyond the disclosure as filed (Rule 70.2(c)):

4. Additional observations, if necessary:

V. Reasoned statement under Article 35(2) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement

1. Statement

Novelty (N)	Yes:	Claims	1-15
	No:	Claims	
Inventive step (IS)	Yes:	Claims	1-15
	No:	Claims	
Industrial applicability (IA)	Yes:	Claims	1-15
	No:	Claims	

2. Citations and explanations

see separate sheet

VII. Certain defects in the international application

The following defects in the form or contents of the international application have been noted:

see separate sheet

VIII. Certain observations on the international application

The following observations on the clarity of the claims, description, and drawings or on the question whether the claims are fully supported by the description, are made:

see separate sheet

Re Item V

Reasoned statement under Article 35(2) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement

The present application relates to the filtering of video signals. This filtering is for example used in de-interlacing, decoding, noise reduction or standards conversion. But in these processes the filtering is realised with complex non-linear filters.

The aim of the present application is to have a relatively simple filter architecture. This is achieved by the method as claimed in claim 1 and by the apparatus as claimed in claim 8.

The prior art, as represented by US-A-5652620 (D1), neither discloses nor suggests the claimed subject-matter: there is no hint in D1 to multiply filtered signals together as claimed (on figure 36 non-filtered signals are multiplied by filtered signals).

The requirements of Article 33(4) PCT are met.

Re Item VII

Certain defects in the international application

The features of the claims are not provided with reference signs placed in parentheses (Rule 6.2(b) PCT).

Re Item VIII

Certain observations on the international application

Claim 15, which is an apparatus claim, cannot depend on claim 6, which is a method claim.

P2E-06-00

first and second filters; and a second multiplier for multiplying together the respective outputs of the first multiplier and the third filter to produce an output video signal.

Advantageously, a filter is interposed between the output of the first multiplier and the second multiplier.

Preferably, the apparatus further comprises a linear filter path connected with the input terminal, and a combiner for combining the outputs of the linear filter path with the output of said second multiplier.

Suitably, a filter is interposed between the output of the second multiplier and said combiner.

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Figure 2 is a diagram similar to Figure 1, illustrating a modification.

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In Figure 1, the new architecture can be seen to consist of two signal paths. A linear signal path 10 contains a traditional, vertical, six tap, linear filter (h_{lin}) which has a typical sin(x)/x structure. If this were to be used without the non-linear signal path it would produce reasonable pictures, but they would contain some artefacts due to the interpolation process, notably jagging on diagonal and curved edges.

In the non-linear signal path 20, the output of two four point linear filters (h_1 and h_2) are multiplied together and passed through a two point linear filter (h_4). The output of this is then multiplied with the output of a five point linear filter (h_3). The resulting signal is filtered through another two point linear filter (h_5) before being added on to the linear path. Although in this case the

In summary, the new architecture is able to reduce many of the artefacts associated with traditional linear interpolation whilst being relatively simple to implement.

Figure 2 illustrates a modification in which the architecture is simplified through omission of the filters h_4 and h_5. In other words, the direct product is formed of the outputs of filters h_1, h_2 and h_3 without intervening filtering of the product of the outputs of filters h_1 and h_2. This may under some circumstances produce less ideal filter behaviour, but the reduction in hardware complexity will often more than compensate. A particular advantage is that the three remaining filters can all make use of the same memory architecture.

It should be understood that this invention has been described by way of example only and that a wide variety of modifications are possible without departing from the scope of the invention. Thus, whilst the separation into linear and non-linear paths offers important advantages, such as the option to preserve higher bit accuracy in the linear path, it will not always appropriate. Similarly, the described use of vertical filters is - as has been explained - merely an example. Horizontal, vertical and temporal filters can be employed and filters can have one, two or three of these dimensions. Whilst Finite Impulse Response (FIR) filters will be important, the invention also encompasses other forms of linear filter such as recursive filters which include the output pixel in the weighted sum. The filters which are to be multiplied together need not be of the same category. However, providing three FIR or transversal filters with the same filter aperture ensures that in the multiplication of the three filtered signals, all possible cross products of input pixels are made available.

It will be recognised that although de-interlacing has been chosen as an example, filters according to the present invention can be applied to other problems in video processing, including composite to component decoding, enhancement, noise reduction, up and down conversion and standards conversion -.

05-06-00

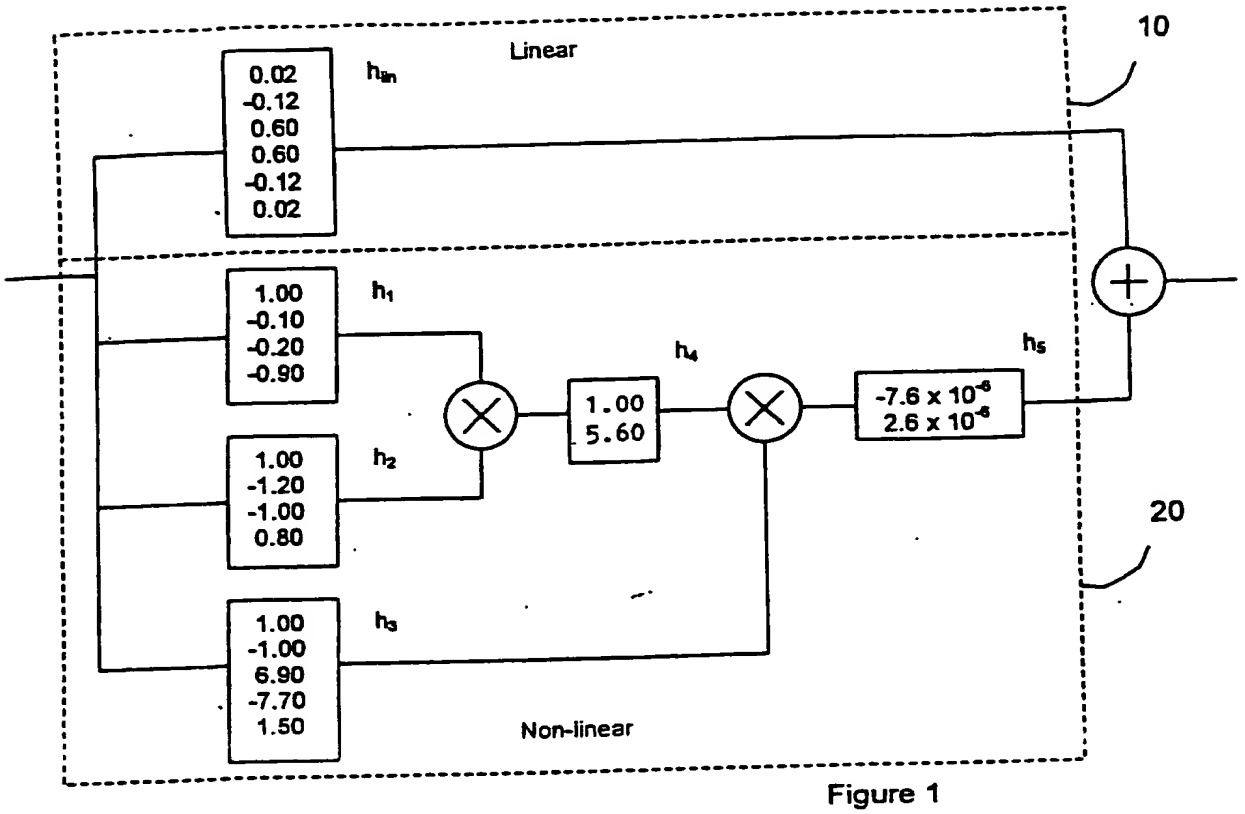

Figure 1

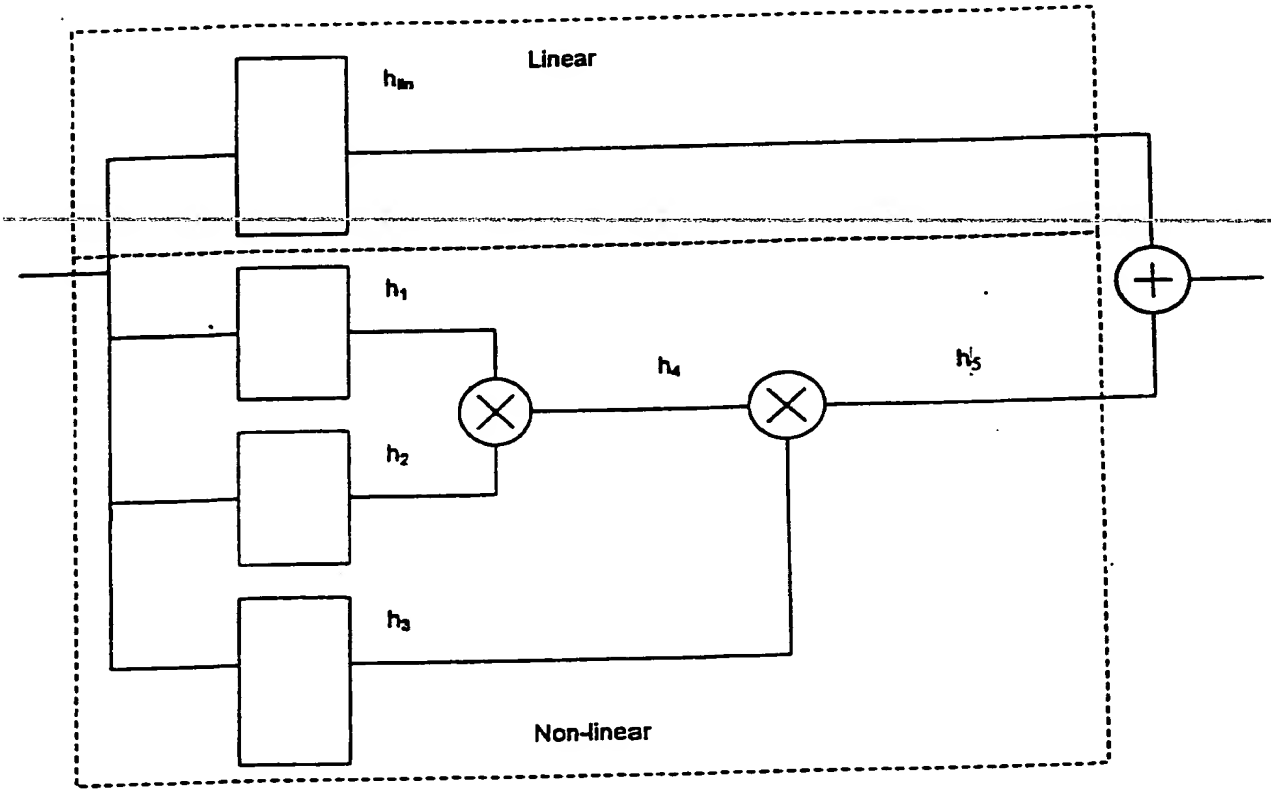

Figure 2

PATENT COOPERATION TREATY

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INTERNATIONAL SEARCH REPORT

(PCT Article 18 and Rules 43 and 44)

Applicant's or agent's file reference	FOR FURTHER ACTION	see Notification of Transmittal of International Search Report (Form PCT/ISA/220) as well as, where applicable, item 5 below.
PDG/20637		
International application No.	International filing date *(day/month/year)*	(Earliest) Priority Date *(day/month/year)*
PCT/GB 99/ 01574	17/05/1999	15/05/1998
Applicant		
SNELL & WILCOX LIMITED et al.		

This International Search Report has been prepared by this International Searching Authority and is transmitted to the applicant according to Article 18. A copy is being transmitted to the International Bureau.

This International Search Report consists of a total of 2 sheets.

[X] It is also accompanied by a copy of each prior art document cited in this report.

1. **Basis of the report**

a. With regard to the **language,** the international search was carried out on the basis of the international application in the language in which it was filed, unless otherwise indicated under this item.

[ ] the international search was carried out on the basis of a translation of the international application furnished to this Authority (Rule 23.1(b)).

b. With regard to any **nucleotide and/or amino acid sequence** disclosed in the international application, the international search was carried out on the basis of the sequence listing :

[ ] contained in the international application in written form.

[ ] filed together with the international application in computer readable form.

[ ] furnished subsequently to this Authority in written form.

[ ] furnished subsequently to this Authority in computer readble form.

[ ] the statement that the subsequently furnished written sequence listing does not go beyond the disclosure in the international application as filed has been furnished.

[ ] the statement that the information recorded in computer readable form is identical to the written sequence listing has been furnished

2. [ ] **Certain claims were found unsearchable** (See Box I).

3. [ ] **Unity of invention is lacking** (see Box II).

4. With regard to the **title,**

[X] the text is approved as submitted by the applicant.

[ ] the text has been established by this Authority to read as follows:

5. With regard to the **abstract,**

[X] the text is approved as submitted by the applicant.

[ ] the text has been established, according to Rule 38.2(b), by this Authority as it appears in Box III. The applicant may, within one month from the date of mailing of this international search report, submit comments to this Authority.

6. The figure of the **drawings** to be published with the abstract is Figure No. 1

[X] as suggested by the applicant.

[ ] None of the figures.

[ ] because the applicant failed to suggest a figure.

[ ] because this figure better characterizes the invention.

INTERNATIONAL SEARCH REPORT

International Application No
PCT/GB 99/01574

A. CLASSIFICATION OF SUBJECT MATTER
IPC 6 H04N5/44

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
IPC 6 H04N

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category °	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 5 652 620 A (ASAKAWA KATSUMI ET AL) 29 July 1997 (1997-07-29) column 12, line 35 - line 63; figures 26,33,35,36 column 17, line 52 - column 18, line 32 column 19, line 22 - column 20, line 11	1,6,8,13

☐ Further documents are listed in the continuation of box C.

☒ Patent family members are listed in annex.

° Special categories of cited documents :

"A" document defining the general state of the art which is not considered to be of particular relevance

"E" earlier document but published on or after the international filing date

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"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art.

"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
12 August 1999	20/08/1999

Name and mailing address of the ISA	Authorized officer
European Patent Office, P.B. 5818 Patentlaan 2 NL - 2280 HV Rijswijk Tel. (+31-70) 340-2040, Tx. 31 651 epo nl, Fax: (+31-70) 340-3016	Yvonnet, J

1

Form PCT/ISA/210 (second sheet) (July 1992)

INTERNATIONAL SEARCH REPORT

Information on patent family members

International Application No
PCT/GB 99/01574

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
US 5652620 A	29-07-1997	EP 0554035 A	04-08-1993
		JP 2821072 B	05-11-1998
		JP 6086302 A	25-03-1994
		US 5450124 A	12-09-1995